

AD-A128 274

MULTIPURPOSE SEMICONDUCTOR LASER EQUIPMENT(U) FOREIGN  
TECHNOLOGY DIV WRIGHT-PATTERSON AFB OH  
Z FANMING ET AL. 06 APR 83 FTD-ID(RS)T-1746-82

1/1

JNCLASSIFIED

F/G 20/5

NL

U

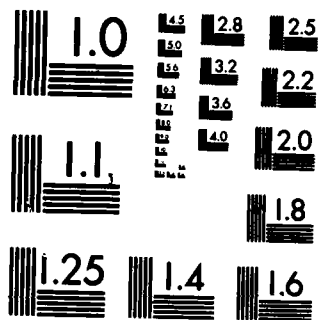
0.1 3

END

DATE

FILED

DTIC



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

2

FTD-ID(RS)T-1746-82

# FOREIGN TECHNOLOGY DIVISION



MULTIPURPOSE SEMICONDUCTOR LASER EQUIPMENT

by

Zhou Fanming, Fan Jinsheng and Wang Deyuan

AD A 128274

DTIC FILE COPY



DTIC  
ELECTE  
MAY 19 1983  
S D D

Approved for public release;  
distribution unlimited.

83 05 19 075

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	



FTD-ID(RS)T-1746-82

## EDITED TRANSLATION

FTD-ID(RS)T-1746-82

6 April 1983

MICROFICHE NR: FTD-83-C-000375

MULTIPURPOSE SEMICONDUCTOR LASER EQUIPMENT

By: Zhou Fanming, Fan Jinsheng and Wang Deyuan

English pages: 12

Source: Dianzi Jishu, Nr. 7, 1982, pp. 41-43

Country of origin: China

Translated by: LEO KANNER ASSOCIATES

F33657-81-D-0264

Requester: FTD/TQCS

Approved for public release; distribution unlimited.

THIS TRANSLATION IS A RENDITION OF THE ORIGINAL FOREIGN TEXT WITHOUT ANY ANALYTICAL OR EDITORIAL COMMENT. STATEMENTS OR THEORIES ADVOCATED OR IMPLIED ARE THOSE OF THE SOURCE AND DO NOT NECESSARILY REFLECT THE POSITION OR OPINION OF THE FOREIGN TECHNOLOGY DIVISION.

PREPARED BY:

TRANSLATION DIVISION  
FOREIGN TECHNOLOGY DIVISION  
WP.AFB, OHIO.

FTD-ID(RS)T-1746-82

Date 6 Apr 19 83

**GRAPHICS DISCLAIMER**

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

## ELECTRONIC CIRCUITS

### MULTIPURPOSE SEMICONDUCTOR LASER EQUIPMENT

Zhou Fanming, Fan Jinsheng and Wang Deyuan

The light source of the multipurpose equipment introduced in this paper uses the homogeneous-knot or single heterogeneous-knot GaAlAs/GaAs semiconductor laser, which possesses not only high anti-noise capability, good security, long-distance transmission (reaching tens to hundreds of meters), and low electricity consumption, its controller can also be utilized for alarming, switch, counting, etc. The equipment can be used in textile industry for broken-thread control and counting, in the electro-mechanical and chemical industries for long-distance speed measurement, alarming, counting, etc. It can also be used in the reservoirs, along the rivers, or in water towers to alarm or control the rise of water level, and so on.

This multipurpose equipment consists of a semiconductor laser emitter and a receiver. The emitter emits the laser beam, while the receiver accomplishes the function of alarming, switch and counting after receiving the beam.

Figs. 1 and 2 show respectively the block diagram and the circuit of the semiconductor laser emitter. In the circuit the transistors  $BG_1$  and  $BG_2$  constitute the 'push-pull' type DC transformer, which transforms the low voltage DC currents into AC

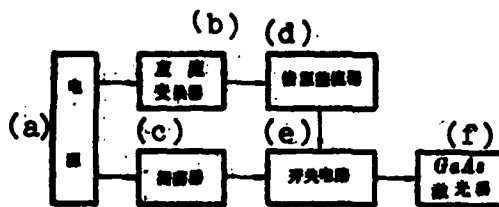


Fig. 1.

Key: (a) Electric Source;  
 (b) D.C. Transformer;  
 (c) Oscillator; (d) Double-  
 Voltage Rectifier; (e) Switch  
 Circuit; (f) GaAs Laser

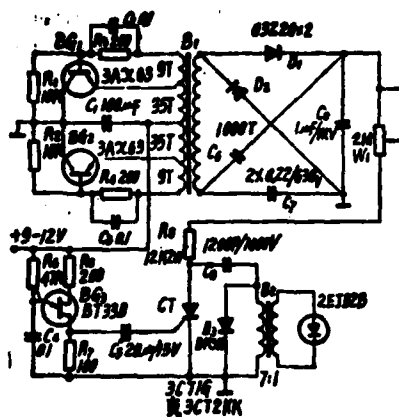


Fig. 2.

currents. The transformer  $B_1$  then raises the voltage and 'double-voltage' rectifying the currents into high voltage DC. Under normal conditions the voltage is about 500 - 700 volts.

The oscillator consists of the 'single-knot' transistor  $BG_3$  and corresponding resistor and capacitor. The output frequency of the impulses can be adjusted by means of changing the values of  $R_5$  and  $C_4$ . The oscillating period of  $BG_3$  can be calculated

from the equation,  $T = RC \ln(1/(1-\eta))$ , where  $R$  and  $C$  are respectively  $R_5$  and  $C_4$  in Fig. 2, and  $\eta$  is the partial pressure ratio of the tubes. Here,  $\eta = 0.6$ ,  $R_5 = 47 \text{ Kohm}$ ,  $C_4 = 0.1 \text{ }\mu\text{f}$ , therefore,  $T = 1000 \text{ }\mu\text{sec}$ . The excited impulses can reach the control electrode of the silicon controlled rectifier through the coupling of  $C_5$ .

When the silicon controlled rectifier CT terminates, the 'double-voltage' rectified high voltage charges the capacitor  $C_9$  on the CT anode through the capacitor  $W_1$  and resistor  $R_8$ . When  $BG_3$  outputs excited impulses that activates CT,  $C_9$  discharges rapidly the first-grade of the transformer  $B_2$  through CT. This forms high voltage impulses that excite the second grade of  $B_2$ , the laser tube 2EJD2B to emit light. If we disconnect the transformer  $B_2$ , and instead using a 0.1 ohm resistor for loading, then from this resistor we can obtain a spike impulse of about 10 - 90 amp, as shown in Fig. 3.

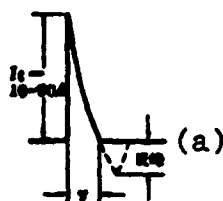


Fig. 3.

Key: (a) Anti-peak  
(the dashed curve)

The value of the impulse width  $\tau$  is related to the RC time constant of the discharging return circuit.  $R$  can be the sum of the internal resistance of the silicon controlled rectifier CT and the resistant value of the first-grade of the transformer  $B_2$ . The impulse width can be conveniently adjusted by changing the

size of  $C_9$ . Here one should note that the silicon controlled rectifier is not those commonly used, but is those elements of high or medium power and possessing high-speed switch time; the switch-on time of these elements is about  $t_d \leq 50 - 60$  nanoseconds. Those better ones are such as 3CT1G, 3CT2KJ, 3CT2KK, etc.

If the anti-impulse of the output impulse currents is too large (the dashed curve shown in Fig. 3), caution must be taken on whether  $D_3$  is misconnected or reverse connected. If the connection is correct and there is still a large anti-impulse, one can connect several diodes of good switch quality in parallel and at the same time adjust the wires of the discharging circuit to reduce the capacity distribution of the return circuit to as small as it possibly can be, until a satisfactory waveform is reached.

The transformer  $B_1$  uses the double-wire winding method. Be careful not to mix up the ends of the same sign. Its first-grade uses  $\varnothing 0.21$  mm wire, and its second-grade uses  $\varnothing 0.12$  mm wire.

The semiconductor laser element 2EJD2B in the circuit is equivalent to a  $0.1 - 0.2$  ohm resistor. Because  $W_1$  and  $R_8$  in the circuit are for charging and current-limiting, frequency is generally no greater than 10 kHz. The frequency used in this equipment is 1 kHz.

The impulse transformer  $B_2$  is a voltage-reduction output transformer; it enhances the electrical currents. Its first- and second-grade ratio is 7:1.  $B_2$  uses  $\varnothing 10 \times \varnothing 5 \times 5$  (mm) circular iron oxide magnetic core, but it can also use MX-1000 or MX-2000.

Figures 4 and 5 show respectively the block diagram and circuit of the multipurpose receiver. The receiver uses the silicon light-sensitive triode 3DU5C(GB) as the light-electricity

transformer that responds to the 9000 Å light wavelength as the peak receiving value. As shown in Fig. 6A, the light impulses are transformed into negative electric impulses; within the transmission distance of several hundred m the amplitude of these signals is about 0.1 - 0.3 mV. Such weak signals are transmitted to the high input resistance foreground amplifier. The foreground amplifier BG<sub>1</sub> uses knot-type field-induction tube 3DJ4F; its input resistance can reach 10 billion ohm. The foreground circuit possesses fine quality of high-frequency responses. Adjusting R<sub>5</sub> to allow I<sub>D</sub> in BG<sub>1</sub> to be around 0.2 - 0.6 mA will put that grade to work normally.

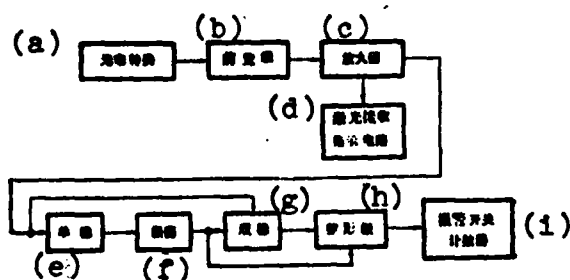


Fig. 4.

Key: (a) Light-Electricity Transformation; (b) Foreground Grade; (c) Amplifier; (d) Laser-Receiving Indicator Circuit; (e) Single Equilibrium; (f) Oscillation; (g) Double Equilibrium; (h) Waveform Rectifying Grade; (i) Switch Alarm Counter

After foreground amplifying the weak impulse signal becomes positive spike impulse, which is then transmitted to the impulse amplifying circuit that consists of a 4th grade 7XF3(5G722) linear integrated circuit for voltage amplifying. 7XF3 is a two-tube direct coupling, negative feed back, wide-band amplifier.

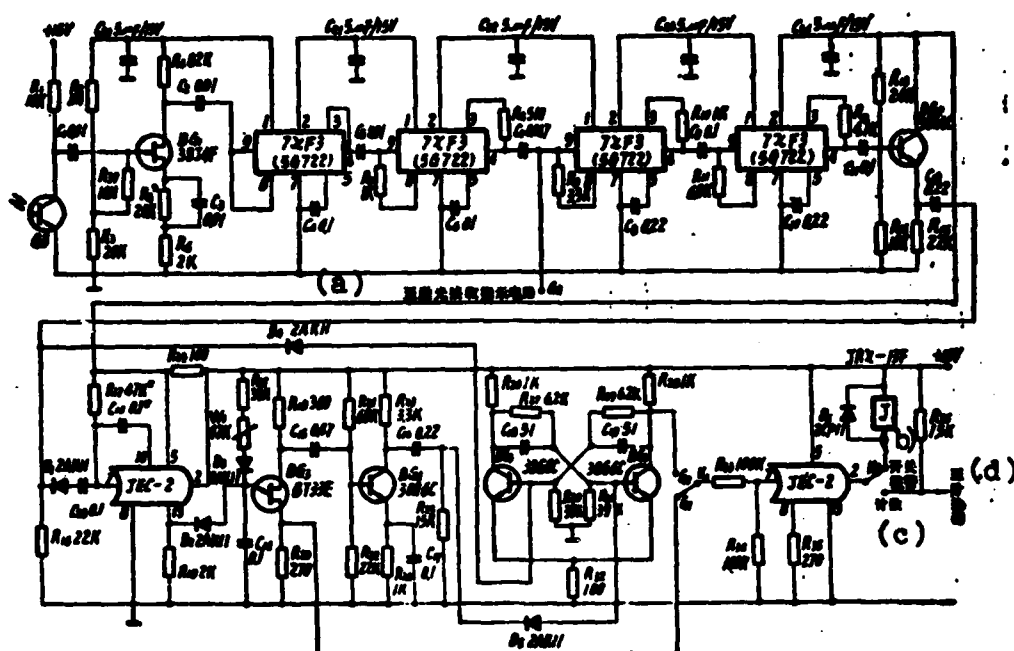


Fig. 5.  
Key: (a) To Laser-Receiver Indicator Circuit; (b) Switch Alarm; (c) Counting; (d) To Counter

When it is used as a high voltage-enhancing amplifier, several elements must be added to the circuit: (1) Adding compensation capacitors  $C_4$ ,  $C_8$ ,  $C_6$ , and  $C_{10}$ , the voltage enhancement of the circuit of each grade can reach 25 decibels, and the upper bound of the frequency band can extend to 100 billion hertz. In order to reduce the enhancement of the lower frequency bound, the compensation capacitors are generally confined in the range of 0.1 - 0.33  $\mu$ farad and cannot be higher. (2) In order to reduce the negative feedback in the circuit to increase the amplifying power in closed circuit, resistors are connected between the 8th and 9th foot of the second, third and fourth grade amplifiers. (3) In order to gradually increase the dynamic range of the voltage output, resistors are connected to the third and fourth feet of each grade. After the above treatments, the voltage amplifying enhancement of the whole amplifier can reach 100 decibels, which will have very fine responses to very narrow high-frequency impulses. Each grade is connected with decoupling capacitor, which prevents the self-excitation induced by the electric source.

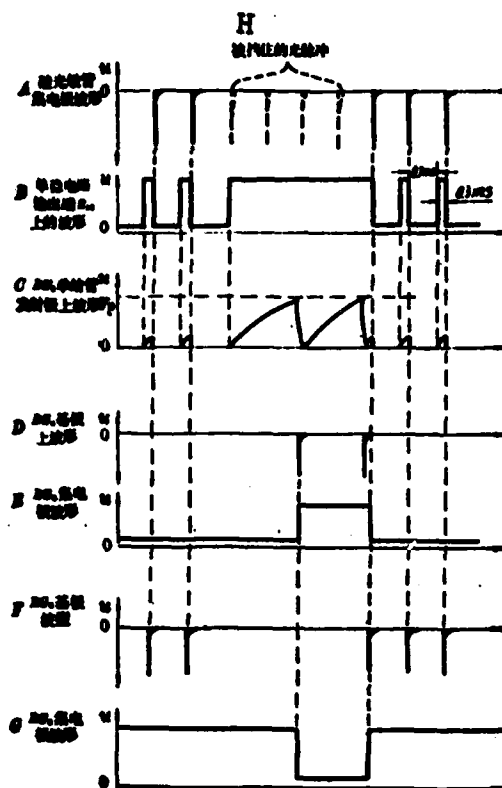


Fig. 6.

Key: A: Silicon light-sensitive integrated electrode waveform;  
 B: Waveform at the output end  $R_{18}$  of the single equilibrium circuit;  
 C: Waveform at the emitter of the single-knot tube  $BG_3$ ; D: Waveform at the base electrode of  $BG_6$ ;  
 E: Waveform at the integrated electrode of  $BG_6$ ; F: Waveform at the base electrode of  $BG_5$ ; G: Waveform at the integrated electrode of  $BG_5$ ;  
 H: Shaded light impulses.

The amplifier outputs positive impulses of 1 kHz in frequency through  $BG_2$  and then differentiated by  $R_{16}$  and  $C_{12}$ . Negative impulses are transmitted through  $D_1$  to the single equilibrium circuit consisting of JEC-2, which synchronizes with the light impulse frequency with a frequency of 1 kHz and then proceeds to turn over. The values of  $R_{17}$  and  $C_{13}$  are adjusted to make the time-lag range to be 0.7 msec and the termination range to be 0.3 msec (see Fig. 6B). At this moment as long as there is a normal input of light impulses, the output voltage of the single equilibrium circuit (the voltage in the resistor  $R_{18}$  is approximately 1 volt) is lower than the voltage  $V_p$  of the peak oscillation value of  $BG_3$  (about 6 volt).  $D_2$  is positive conductive, the charging currents in the capacitor  $C_{14}$  go through  $D_2$  and  $R_{18}$  and discharge to the ground. In this way  $BG_3$  will not oscillate and no signal outputs from the  $G_1$  end (see Fig. 6C).

The other negative impulses that were differentiated by  $R_{16}$  and  $C_{12}$  are transmitted through  $D_4$  to the base electrode of the double equilibrium circuit  $BG_5$  (see Fig. 6F), which causes a reliable termination of  $BG_5$  and turns on  $BG_6$ , the  $G_2$  end is then under low voltage (see Figure 6E).

$W_1$  and  $C_{14}$  are adjusted to make the oscillating frequency of the oscillator to be 400 - 500 hertz, which is much lower than the working frequency of the single equilibrium circuit (about 1/2). When the single equilibrium state automatically turns over, the output end of the single equilibrium circuit is at high voltage (about 11 volt), greater than the voltage  $V_p$  of the peak oscillating value of  $BG_3$ , and  $D_2$  is under opposite termination. Therefore, the electric source charges  $C_{14}$  through  $W_1$ ,  $R_{37}$  and  $D_3$  in 0.3 msec (see Fig. 6C). Because the time is extremely short, the peak voltage value of  $BG_3$  is not yet reached, the single equilibrium voltage is excited by the light impulses of 1 kHz to become terminated and delayed. Then  $D_2$  positively deviates, and  $C_{14}$

discharges. Therefore, as long as the laser 2EJD2B emits normally, the light-sensitive tube receives normally,  $BG_3$  will never oscillate, and there will be no output from the  $G_2$  end.

When the light is shaded, there will be no signal impulses output from the simplifying grade of the receiver, and no excited impulses in the single equilibrium circuit and the base electrode of  $BG_5$ , the single equilibrium circuit turns over from the termination state to the equilibrium state, and the voltage at the resistor  $R_{18}$  of the output end of the single equilibrium circuit changes rapidly to a high voltage of about 11 volts. At this moment, there is sufficient time for the electric source to charge  $C_{14}$  through  $W_1$ ,  $R_{37}$  and  $D_2$  until  $V_p$  is reached, then  $BG_3$  starts to oscillate (see Fig. 6C). The output negative impulses, after being inversely amplified and differentiated by  $BG_4$ , excite the base electrode of  $BG_6$  (see Fig. 6D), which causes  $BG_6$  to turn over from conduction to termination (see Fig. 6E); i.e., the output of the  $G_2$  jumps from low voltage to high voltage.

When the light shade is removed, light-sensitive tube again receives the light impulses emitted from the laser 2EJD2B, which causes the single equilibrium circuit to turn over again from the equilibrium state to termination.  $BG_3$  then stops oscillation, the voltage of the integrated electrode of  $BG_6$  drops rapidly, and the voltage of the  $G_2$  end drops rapidly (see Fig. 6E).

In order to adapt to different needs, the receiver utilizes multiple outputs. The output is from the integrated electrode of  $BG_6$  to the  $G_1$  end; the other is from the  $B_1$ -electrode of  $BG_3$  to the  $G_1$  end. However, the waveform and amplitude of the impulses output from the  $G_1$  and  $G_2$  ends are not ideal and cannot be directly used as the signals. It is therefore necessary to select JEC-w integrated blocks to be the impulse rectifying circuit, which will rectify both the spike impulses output from the  $G_1$  end and

the step waves (but both the front and rear edges are not vertical) output from the  $G_2$  end to become rectangular impulses of the same amplitude.

1. When  $K_1$  is placed at the  $G_1$  end:

(1)  $K_2$  is placed at the switch alarm end. In case there is an object that shades the laser beam, the  $G_1$  end will output 400-500 hertz spike impulses. After the waveform is rectified, the relay J will then be self-protecting and continuously absorbing, and utilizing indication light of the loudspeaker for alarming.

(2) When  $K_2$  is placed at the end of the 1.5 K resistor, the laser beam is shaded by an object. The waveform-rectifying grade then outputs rectangular impulses of the same oscillating frequency as that of  $BG_3$  to the counter for counting. When the object is removed from the laser beam, the counter stops counting. In this way the speed of a linearly moving object can be measured. For instance, an object has a length of 10 m, the oscillation frequency of  $BG_3$  is 500 hertz, the number of counts shown by the counter during the blockade of the laser beam by the object is 500, then the time that the object passed through the laser beam measuring point is  $t = 500 / 500 \text{ hertz} = 1 \text{ sec}$ , and the speed of the object is  $s = 10 \text{ m/sec}$ .

2. When  $K_1$  is placed at the  $G_2$  end,

(1)  $K_2$  is placed at the switch alarm end. This means when there are light impulses at the receiver the relay does not move, while there is no light impulse at the receiver the relay absorbs and moves.

(2)  $K_2$  is placed at the counting end that counts each time the laser beam is shaded. Whether the count is the number of the light shaded by the object or the number of the object leaving the light is dependent upon the excitation requirements of the counter

Under normal conditions the repeat frequency of the laser of about 1 kHz is sufficient. In case the measuring speed or accuracy needs to be raised, then the repeat frequency of the electric source of the laser as well as the working frequencies of the single equilibrium circuit and the oscillator need also to be correspondingly raised. However, the ratio of the light impulse frequency and the oscillation frequency must be kept at 2:1, otherwise the anti-noise quality of the receiver will be greatly reduced.

11

In order for long-distance usage, this receiver uses 4th grade amplification. If the usage distance is shorter, the grade of amplification can be correspondingly reduced. In order to fully utilize the light energy and to prevent diffusion, the optical system needs lenses to focus the light beams. Generally the diffusion and receiving scopes use single lenses with a diameter around 20 - 40 mm (either single convex, flat convex, or double convex) to adjust the laser beams in parallel. The ratio between the lens diameter and the focal distance is about 1:3 - 1:4; i.e., the focal distance  $f=80 - 120$  mm. During installment and adjustment the center lines of the laser and of the light-sensitive tube of the receiver must be focused at the focus of the lens, otherwise the effective distance will be shortened.

# DISTRIBUTION LIST

## DISTRIBUTION DIRECT TO RECIPIENT

<u>ORGANIZATION</u>	<u>MICROFICHE</u>
A205 DMAHTC	1
A210 DMAAC	1
B344 DIA/RTS-2C	9
C043 USAMIIA	1
C500 TRADOC	1
C509 BALLISTIC RES LAB	1
C510 R&T LABS/AVRADCOM	1
C513 ARADCOM	1
C535 AVRADCOM/TSARCOM	1
C539 TRASANA	1
C591 FSTC	4
C619 MIA REDSTONE	1
D008 NISC	1
E053 HQ USAF/INET	1
E403 AFSC/INA	1
E404 AEDC/DOF	1
E408 AFWL	1
E410 AD/IND	1
E429 SD/IND	1
P005 DOE/ISA/DDI	1
P050 CIA/OCR/ADD/SD	2
AFTT/LDE	1
FTD	
CCN	1
NIA/PHS	1
NIIS	2
LLNL/Code L-389	1
NASA/NST-44	1
NSA/1213/TDL	2